U.S. DEPARTMENT OF COMMERCE
National Technical Information Service

PB-268 309

# Lake Lavon
# Collin County, Texas

National Eutrophication Survey, Corvallis, Oreg

Prepared for

Corvallis Environmental Research Lab, Oreg

Feb 77

TECHNICAL REPORT DATA

(Please read Instructions on the reverse before completing)

| | |
|---|---|
| 1. REPORT NO. | 2. |
| 3. TITLE AND SUBTITLE: Report on Lake Lavon, Collin County, Texas | 5. REPORT DATE: Prepared February 1977 |
| 7. AUTHOR(S): Anonymous (National Eutrophication Survey Staff) | 8. PERFORMING ORGANIZATION REPORT NO.: Working Paper # 649 |
| 9. PERFORMING ORGANIZATION NAME AND ADDRESS: National Eutrophication Survey, U.S. Environmental Protection Agency, 200 S. W. 35th St., Corvallis, Oregon 97330 | 10. PROGRAM ELEMENT NO. |
| | 11. CONTRACT/GRANT NO. |
| 12. SPONSORING AGENCY NAME AND ADDRESS: Office of Research and Development, U.S. Environmental Protection Agency, 401 M Street, S. W., Washington, DC 20460 | 13. TYPE OF REPORT AND PERIOD COVERED: Final - 1974; 14. SPONSORING AGENCY CODE |

15. SUPPLEMENTARY NOTES: Prepared in cooperation with the U.S. Environmental Protection Agency, National Environmental Research Center, Las Vegas, Nevada 89114

16. ABSTRACT:

Annual total phosphorus and total nitrogen loadings to the lake were estimated and subdivided according to either point or non-point source origin. An assessment of the lake's trophic condition and limiting nutrient is also provided. All data collected by the U.S.E.P.A. National Eutrophication Survey during the one year study of the lake and its tributaries are included in the report.

17. KEY WORDS AND DOCUMENT ANALYSIS

| a. DESCRIPTORS | b. IDENTIFIERS/OPEN ENDED TERMS | c. COSATI Field/Group |
|---|---|---|
| eutrophication<br>lakes<br>nutrients<br>phosphorus<br>nitrogen<br>loading | | 05B<br>05C |

18. DISTRIBUTION STATEMENT: Release unlimited

19. SECURITY CLASS (This Report): 21. NO. OF PAGES: 67

20. SECURITY CLASS (This page): 22. PRICE:

EPA Form 2220-1 (9-73)

PB 268 309

# U.S. ENVIRONMENTAL PROTECTION AGENCY
# NATIONAL EUTROPHICATION SURVEY

## WORKING PAPER SERIES

CORVALLIS ENVIRONMENTAL RESEARCH LABORATORY - CORVALLIS, OREGON
and
ENVIRONMENTAL MONITORING & SUPPORT LABORATORY - LAS VEGAS, NEVADA

REPRODUCED BY
NATIONAL TECHNICAL
INFORMATION SERVICE
U.S. DEPARTMENT OF COMMERCE
SPRINGFIELD, VA. 22161

REPORT

ON

LAKE LAVON

COLLIN COUNTY

TEXAS

EPA REGION VI

WORKING PAPER NO. 640

WITH THE COOPERATION OF THE

TEXAS WATER QUALITY BOARD

AND THE

TEXAS NATIONAL GUARD

FEBRUARY, 1977

i

CONTENTS


| | Page |
|---|---|
| Foreward | ii |
| List of Texas Study Reservoirs | iv |
| Lake and Drainage Area Map | vi |
| Sections | |
| I. Conclusions | 1 |
| II. Lake and Drainage Basin Characteristics | 3 |
| III. Lake Water Quality Summary | 4 |
| IV. Nutrient Loadings | 10 |
| V. Literature Reviewed | 16 |
| VI. Appendices | 17 |

# FOREWORD

The National Eutrophication Survey was initiated in 1972 in response to an Administration commitment to investigate the nationwide threat of accelerated eutrophication to freshwater lakes and reservoirs.

## OBJECTIVES

The Survey was designed to develop, in conjunction with state environmental agencies, information on nutrient sources, concentrations, and impact on selected freshwater lakes as a basis for formulating comprehensive and coordinated national, regional, and state management practices relating to point-source discharge reduction and non-point source pollution abatement in lake watersheds.

## ANALYTIC APPROACH

The mathematical and statistical procedures selected for the Survey's eutrophication analysis are based on related concepts that:

a. A generalized representation or model relating sources, concentrations, and impacts can be constructed.

b. By applying measurements of relevant parameters associated with lake degradation, the generalized model can be transformed into an operational representation of a lake, its drainage basin, and related nutrients.

c. With such a transformation, an assessment of the potential for eutrophication control can be made.

## LAKE ANALYSIS

In this report, the first stage of evaluation of lake and watershed data collected from the study lake and its drainage basin is documented. The report is formatted to provide state environmental agencies with specific information for basin planning [§303(e)], water quality criteria/standards review [§303(c)], clean lakes [§314(a,b)], and water quality monitoring [§106 and §305(b)] activities mandated by the Federal Water Pollution Control Act Amendments of 1972.

Beyond the single lake analysis, broader based correlations between nutrient concentrations (and loading) and trophic condition are being made to advance the rationale and data base for refinement of nutrient water quality criteria for the Nation's fresh water lakes. Likewise, multivariate evaluations for the relationships between land use, nutrient export, and trophic condition, by lake class or use, are being developed to assist in the formulation of planning guidelines and policies by EPA and to augment plans implementation by the states.

ACKNOWLEDGEMENT

The staff of the National Eutrophication Survey (Office of Research & Development, U. S. Environmental Protection Agency) expresses sincere appreciation to the Texas Water Quality Board for professional involvement, to the Texas National Guard for conducting the tributary sampling phase of the Survey, and to those Texas wastewater treatment plant operators who voluntarily provided effluent samples.

Hugh C. Yantis, Jr., Executive Director of the Texas Water Quality Board, and John B. Latchford, Jr., Director, and the staff of the Field Operations Division provided invaluable lake documentation and counsel during the Survey, reviewed the preliminary reports, and provided critiques most useful in the preparation of this Working Paper series.

Major General Thomas Bishop, the Adjutant General of Texas, and Project Officer Colonel William L. Seals, who directed the volunteer efforts of the Texas National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

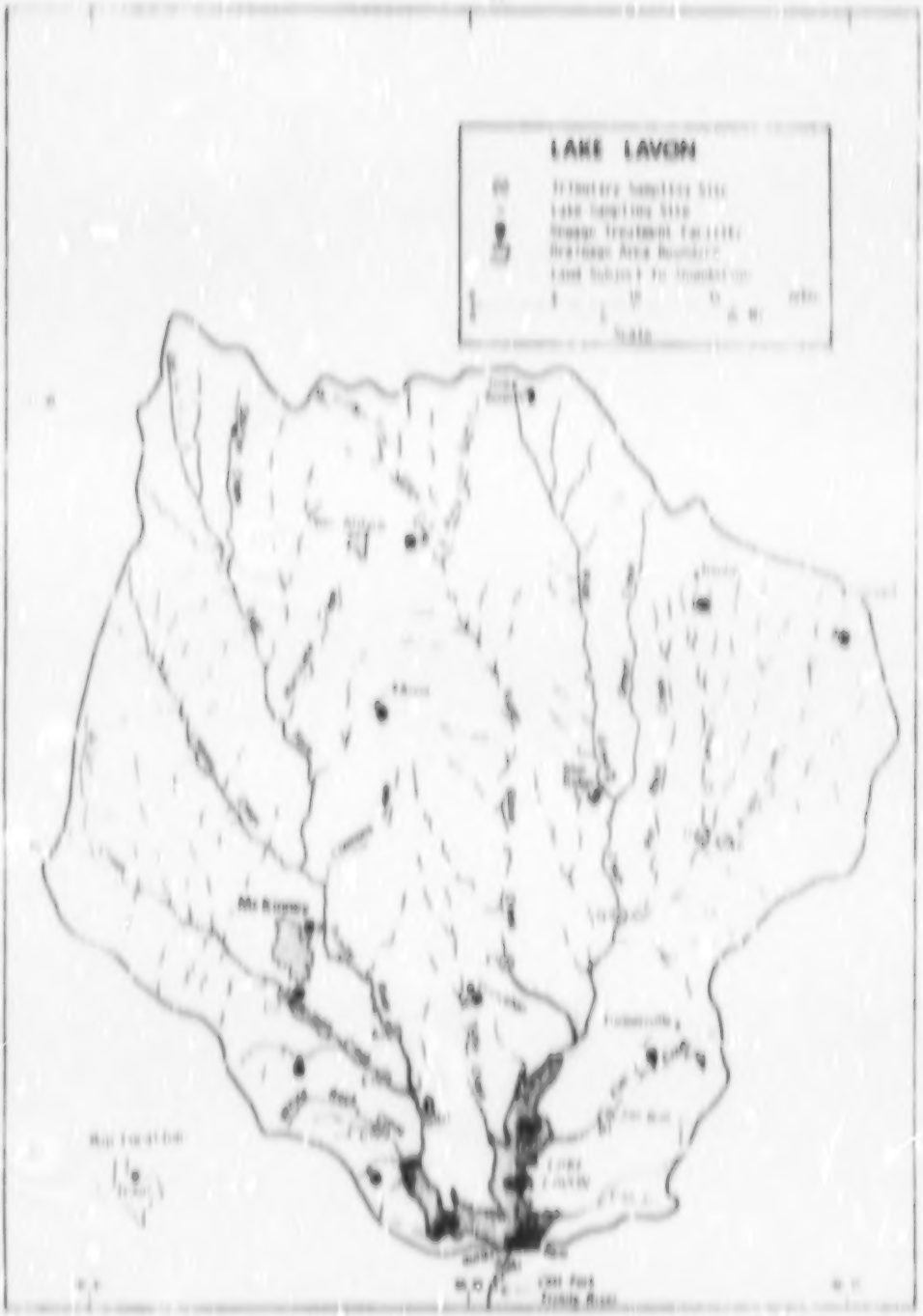
# NATIONAL EUTROPHICATION SURVEY

## STUDY RESERVOIRS

## State of Texas

| NAME | COUNTY |
|---|---|
| Amistad | Val Verde |
| Bastrop | Bastrop |
| Belton | Bell, Coryell |
| Braunig | Bexar |
| Brownwood | Brown |
| Buchanan | Burnet, Llano |
| Caddo | Harrison, Marion, TX; Caddo Parish, LA |
| Calaveras | Bexar |
| Canyon | Comal |
| Colorado City | Mitchell |
| Corpus Christi | Jim Wells, Live Oak, San Patricio |
| Diversion | Archer, Baylor |
| Eagle Mountain | Tarrant, Wise |
| Fort Phantom Hill | Jones |
| Houston | Harris |
| Kemp | Baylor |
| Lake O'The Pines | Camp, Marion, Morris, Upshur |
| Lavon | Collin |
| Lewisville (Garza-Little Elm) | Denton |
| Livingston | Polk, San Jacinto, Trinity, Walker |

| | |
|---|---|
| Lyndon B. Johnson | Burnet, Llano |
| Medina | Bandera, Medina |
| Meredith | Hutchinson, Moore, Potter |
| O. C. Fisher (San Angelo) | Tom Green |
| Palestine | Anderson, Cherokee, Henderson, Smith |
| Possum Kingdom | Palo Pinto, Stephens, Young |
| Sam Rayburn | Angelina, Jasper Nacogdoches, Sabine, San Augustine |
| Somerville | Burleson, Lee, Washington |
| E. V. Spence | Coke |
| Stamford | Haskell |
| Stillhouse Hollow | Bell |
| Tawakoni | Hunt, Rains, Van Zandt |
| Texoma | Cooke, Grayson TX; Bryan, Johnston, Love, Marshall, OK |
| Travis | Burnet, Travis |
| Trinidad | Henderson |
| Twin Buttes | Tom Green |
| White River | Crosby |
| Whitney | Bosque, Hill |
| Wright Patman (Texarkana) | Bowie, Cass |


LAKE LAVON

# LAKE LAVON

## STORET NO. 4819

I. CONCLUSIONS

A. Trophic Condition:

Survey data indicate that Lake Lavon is eutrophic; i.e, well supplied with nutrients and quite productive. Whether nutrient enrichment is beneficial or deleterious depends on the actual or potential effect on the uses of the lake. In this regard, the Texas Water Quality Board has indicated that there is little or no known impairment of the designated beneficial uses of this lake.

Lake Lavon ranked twenty-seventh in overall trophic quality when the 39 Texas reservoirs sampled in 1974 were compared using a combination of six parameters*. Thirty of the reservoirs had less median total phosphorus, 29 had less and two had the same median dissolved orthophosphorus, 26 had less and one had the same median inorganic nitrogen, six had less mean chlorophyll a, and 37 had greater mean Secchi disc transparency. No significant depression of dissolved oxygen with depth (to 6.7 meters) occurred at any of the four sampling times.

Survey limnologists noted the lake was very turbid. The turbidity of Lake Lavon is noted in another report (Maczyqemba, 1974).

B. Rate-Limiting Nutrient:

Due to significant changes in nutrient levels in the sample, the algal assay results are not representative of conditions in the lake at the time the sample was taken.

* See Appendix A.

The lake data indicate that most sampling stations were nitrogen limited in March, August, and October, but all were phosphorus limited in May. However, because of turbidity, primary productivity probably is frequently light-limited rather than nutrient-limited.

C. Nutrient Controllability:

1. Point sources--It is calculated that known point sources contributed about 31% of the total phosphorus load to Lake Lavon during the sampling year. The McKinney South plant contributed nearly 19% of the total phosphorus load.

During the sampling year, the lake received a total phosphorus loading almost 2.5 times that proposed by Vollenweider (Vollenweider and Dillon, 1974) as a eutrophic loading (see page 15). It seems unlikely that even 85% removal of phosphorus at all the treatment plants would result in significant improvement in the trophic condition of the lake, especially in view of the probability that primary productivity frequently is light-limited.

2. Non-point sources--It is estimated that non-point sources contributed about 69% of the total phosphorus load to Lake Lavon during the sampling year. The East Fork of the Trinity River contributed 32.8% of the total phosphorus load, and Wilson and Pilot Grove Creeks contributed 12.2% each.

Note that the phosphorus export rates of the East Fork and Wilson Creek were somewhat high at 94 and 37 kg/km$^2$/yr, respectively (see page 14); these high rates may be due to urban runoff and/or unknown point sources in the vicinity of the City of McKinney.

II. LAKE AND DRAINAGE BASIN CHARACTERISTICS†

A. Lake Morphometry††:

1. Surface area: 88.43 kilometers².

2. Mean depth: 6.5 meters.

3. Maximum depth: 11.9 meters.

4. Volume: 563.131 x $10^6$ $m^3$.

5. Mean hydraulic retention time: 1.4 years (based on 1972-1976 mean outflow).

B. Tributary and Outlet:
(See Appendix C for flow data)

1. Tributaries -

| Name | Drainage area ($km^2$)* | Mean flow ($m^3$/sec)* |
|---|---|---|
| East Fork Trinity River | 536.1 | 4.250 |
| White Rock Creek | 10.1 | 0.149 |
| Wilson Creek | 295.3 | 2.050 |
| Sister Grove Creek | 292.7 | 1.981 |
| Pilot Grove Creek | 507.6 | 3.410 |
| Indian Creek | 115.3 | 0.830 |
| Minor tributaries & immediate drainage - | 184.4 | 0.802 |
| totals | 1,949.5 | 13.452 |

2. Outlet -

| | | |
|---|---|---|
| East Fork Trinity River | 1,994.3** | 10.840** |

C. Precipitation***:

1. Year of sampling: 117.1 centimeters.

2. Mean annual: 96.8 centimeters.

† Table of metric conversions--Appendix B.
†† At conservation pool level; Barrows, 1977.
* For limits of accuracy, see Working Paper No. 175, "...Survey Methods, 1973-1976".
** Includes area of lake; lesser outflow due to evaporation and diversions.
*** See Working Paper No. 175.

III. LAKE WATER QUALITY SUMMARY

Lake Lavon was sampled four times in 1974 by means of a pontoon-equipped Huey helicopter. Each time, samples for physical and chemical parameters were collected from two or more depths at four stations on the lake (see map, page vi). During each visit, a single depth-integrated (4.6 m or near bottom to surface) sample was composited from the stations for phytoplankton identification and enumeration; and during the first visit, a single 18.9-liter depth-integrated sample was composited for algal assays. Also each time, a depth-integrated sample was collected from each of the stations for chlorophyll a analysis. The maximum depths sampled were 6.7 meters at station 1, 3.0 meters at station 2, 4.9 meters at station 3, and 1.8 meters at station 4.

The sampling results are presented in full in Appendix B and are summarized in the following table.

A SUMMARY OF PHYSICAL AND CHEMICAL CHARACTERISTICS FOR LAKES ASSESSED
STREET CODE 4619

| PARAMETER | 1ST SAMPLING - 3/ 6/74 | | | 2ND SAMPLING - 5/28/74 | | | 3RD SAMPLING - 8/13/74 | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 4 SITES | | | 4 SITES | | | 2 SITES | | | |
| | 4616 | | 4618 | 4616 | | 4618 | 4616 | | 4618 | |
| TEMP (C) | 26.0 | - 28.0 | 28.2 | 27.6 | 25.3 | - 27.6 | 25.9 | 25.8 | 27.6 | - 28.0 | 28.3 | 28.3 |
| DISS OXY (MG/L) | 6.8 | - 9.4 | 8.4 | 8.4 | 6.4 | - 7.0 | 6.8 | 6.8 | 6.2 | - 7.0 | 6.7 | 6.8 |
| CNDCTVY (MICROMHO) | 336. | - 345. | 341. | 340. | 334. | - 358. | 344. | 344. | 336. | - 338. | 337. | 338. |
| PH (STAND UNITS) | 8.1 | - 8.2 | 8.1 | 8.1 | 8.1 | - 8.4 | 8.2 | 8.3 | 8.3 | - 8.4 | 8.4 | 8.4 |
| TOT ALK (MG/L) | 131. | - 134. | 132. | 131. | 124. | - 134. | 133. | 132. | 132. | - 140. | 140. | 140. |
| TOT P (MG/L) | 0.056 | - 0.098 | 0.067 | 0.064 | 0.054 | - 0.111 | 0.069 | 0.061 | 0.054 | - 0.060 | 0.061 | 0.075 |
| DRTHO P (MG/L) | 0.011 | - 0.021 | 0.015 | 0.015 | 0.004 | - 0.023 | 0.009 | 0.008 | 0.004 | - 0.007 | 0.004 | 0.006 |
| NO2+NO3 (MG/L) | 0.098 | - 0.128 | 0.105 | 0.108 | 0.101 | - 0.106 | 0.104 | 0.104 | 0.078 | - 0.107 | 0.094 | 0.099 |
| AMMONIA (MG/L) | 0.058 | - 0.068 | 0.070 | 0.070 | 0.029 | - 0.050 | 0.037 | 0.039 | 0.050 | - 0.060 | 0.061 | 0.060 |
| KJEL N (MG/L) | 0.350 | - 0.480 | 0.395 | 0.408 | 0.388 | - 0.780 | 0.446 | 0.480 | 0.360 | - 0.480 | 0.380 | 0.390 |
| NORG N (MG/L) | 0.150 | - 0.288 | 0.175 | 0.178 | 0.328 | - 0.610 | 0.367 | 0.378 | 0.238 | - 0.380 | 0.286 | 0.290 |
| TOTAL N (MG/L) | 0.248 | - 0.528 | 0.351 | 0.358 | 0.648 | - 1.236 | 0.742 | 0.858 | 0.378 | - 0.610 | 0.466 | 0.480 |
| CHLRPHYL A (UG/L) | 1.3 | - 5.2 | 2.1 | 1.7 | 4.8 | - 15.4 | 8.3 | 7.8 | 2.0 | - 6.7 | 4.4 | 3.5 |
| SECCHI (METERS) | 8.3 | - 8.5 | 8.4 | 8.5 | 8.2 | - 8.5 | 8.3 | 8.3 | 8.3 | - 8.5 | 8.4 | 8.4 |

[illegible] SUMMARY OF [illegible] AND CHEMICAL CHARACTERISTICS [illegible]
STREET CASE [illegible]

[illegible] SAMPLING LOCATION

| PARAMETER | RANGE | MEAN | MEDIAN |
|---|---|---|---|
| TEMP (C) | 24.6 - 28.7 | 26.1 | 26.1 |
| [illegible] | 6.6 - 8.6 | 7.6 | 8.1 |
| [illegible] | 256. - 292. | 288. | 282. |
| [illegible] | 8.1 - 8.2 | 8.2 | 8.2 |
| [illegible] | 127. - 136. | 130. | 130. |
| [illegible] | 0.057 - 0.083 | 0.065 | 0.060 |
| [illegible] | 0.022 - 0.028 | 0.024 | 0.025 |
| [illegible] | 0.060 - 0.130 | 0.095 | 0.110 |
| [illegible] | 0.030 - 0.040 | 0.034 | 0.040 |
| [illegible] | 0.280 - 0.400 | 0.317 | 0.300 |
| [illegible] | 0.060 - 0.160 | 0.122 | 0.150 |
| [illegible] | 0.330 - 0.490 | 0.402 | 0.390 |
| [illegible] | 4.8 - 6.2 | 5.1 | 5.0 |
| [illegible] | 8.3 - 8.6 | 8.4 | 8.3 |

B. Biological characteristics:

1. Phytoplankton -

| Sampling Date | Dominant Genera | Algal Units per ml |
|---|---|---|
| 03/08/74 | 1. Melosira sp. | 559 |
| | 2. Centric diatoms | 473 |
| | 3. Chroomonas sp. | 301 |
| | 4. Dactylococcopsis sp. | 129 |
| | 5. Anabaena sp. | 43 |
| | Other genera | 87 |
| | Total | 1,592 |
| 05/20/74 | 1. Melosira sp. | 166 |
| | 2. Cryptomonas sp. | 124 |
| | 3. Stephanodiscus sp. | 124 |
| | 4. Chroomonas sp. | 83 |
| | 5. Chlorophytan cells | 41 |
| | Total | 538 |
| 08/12/74 | 1. Melosira sp. | 506 |
| | 2. Oocystis sp. | 119 |
| | 3. Stephanodiscus sp. | 30 |
| | 4. Closterium sp. | 30 |
| | 5. Chroomonas sp. | 30 |
| | Other genera | 59 |
| | Total | 834 |
| 10/31/74 | 1. Melosira sp. | 1,334 |
| | 2. Stephanodiscus sp. | 714 |
| | 3. Chroomonas sp. | 48 |
| | Total | 2,096 |

B. Chlorophyll A -

| Sampling Date | Station Number | Chlorophyll A (ug/l) |
|---|---|---|
| 03/08/74 | 1 | 1.3 |
| | 2 | 1.7 |
| | 3 | 1.8 |
| | 4 | 5.2 |
| 05/20/74 | 1 | 15.0 |
| | 2 | 8.1 |
| | 3 | 6.0 |
| | 4 | 4.0 |
| 08/12/74 | 1 | 2.9 |
| | 2 | 3.5 |
| | 3 | 6.7 |
| | 4 | - |
| 10/31/74 | 1 | 5.5 |
| | 2 | 4.8 |
| | 3 | 9.1 |
| | 4 | - |

C. Limiting Nutrient Study:

Significant nutrient changes occurred in the assay sample during shipment to the laboratory, and the results are not indicative of conditions in the lake at the time the sample was taken (03/08/74).

The lake data indicate a temporal and spacial combination of limiting nutrients. Following is a tabulation of the mean inorganic nitrogen/orthophosphorus ratios at each of the sampling stations and times with the indicated limiting nutrient in parentheses:

| Station | 03/08/74 | 05/20/74 | 08/12/74 | 10/31/74 |
|---|---|---|---|---|
| 1 | 12/1 (N) | 36/1 (P) | 17/1 (P) | 6/1 (N) |
| 2 | 18/1 (N) | 29/1 (P) | 15/1 (NF) | 5/1 (N) |
| 3 | 11/1 (N) | 32/1 (P) | 15/1 (NF) | 5/1 (N) |
| 4 | 15/1 (P) | 34/1 (P) | * | 5/1 (N) |

As indicated on page 1, Lake Leven is turbid, and primary productivity probably is light-limited at times rather than nutrient-limited. Note that Secchi disc transparencies ranged from 0.2 to 0.6 meters, and only 1% of the incident light remained at depths ranging from 0.6 to 1.5 meters (Appendix D).

## IV. NUTRIENT LOADINGS (See Appendix I for data)

For the determination of nutrient loadings, the Texas National Guard collected monthly near-surface grab samples from each of the tributary sites indicated on the map (page vi), except for the months of April and May when two samples were collected at most of the sites. Sampling was begun in September, 1974, and was completed in August, 1975.

Through an interagency agreement, stream flow estimates for the year of sampling and a "normalized" or average year were provided by the Texas District Office of the U.S. Geological Survey for the tributary sites nearest the lake.

In this report, nutrient loads for gaged and sampled tributaries, except for Indian Creek, were determined by using a modification of a U.S. Geological Survey computer program for calculating stream loadings*. Nutrient loads shown are those measured minus point-source loads, if any.

Nutrient loads for unsampled "minor tributaries and immediate drainage" ("ZZ" of U.S.G.S.) were estimated using the means of the nutrient loads at stations C-1, F-1, and G-1, in kg/km$^2$/year, and multiplying the means by the ZZ area in km$^2$. This method was also used to estimate the non-point loads for Indian Creek which received an estimated point-source phosphorus load greater than the load measured at station J-1.

* See Working Paper No. 175.

The operators of the Farmersville, McKinney, Princeton, Seis Lagos, and Van Alstyne wastewater treatment plants provided monthly effluent samples and corresponding flow data. Posey Mobile Home Acres and the communities of Anna, Blue Ridge, Leonard, Tom Bean, and Trenton did not participate; nutrient loads from these sources were estimated at 1.134 kg P and 3.401 kg N/capita/year, and flows were estimated at 0.3785 $m^3$/capita/day.

A. Waste Sources:

1. Known municipal[a] -

| Name | Pop. Served | Treatment | Mean Flow ($m^3$/d) | Receiving Water |
|---|---|---|---|---|
| Anna | 325 | stab. pond | 123.0 | Throckmorton Creek |
| Blue Ridge | 400 | stab. pond | 151.4 | Pilot Grove Creek |
| Farmersville | 2,500 | tr. filter | 808.7 | Elm Creek |
| Leonard | 1,000 | stab. pond | 378.5 | Arnold Creek |
| McKinney North | 1,500 | tr. filter | 566.1 | Unnamed Stream/ E. Fork Trinity River |
| South | 16,000 | stab. pond | 5,502.5 | Wilson Creek |
| Posey Mobile Home Acres | 28 | act. sludge | 10.6 | Sloan Creek |
| Princeton | 2,000 | stab. pond | 951.6 | Ticky Creek |
| Seis Lagos | 40 | act. sludge | 76.1 | White Rock Creek |
| Tom Bean | 400 | stab. pond | 151.4 | Pilot Grove Creek |
| Trenton | 650 | stab. pond | 246.0 | Indian Creek |
| Van Alstyne | 2,000 | tr. filter | 640.8 | Sister Grove Creek |

2. Known industrial - None

[a] Treatment plant questionnaires; Anonymous, 1971.

B. Annual Total Phosphorus Loading - Average Year:

1. Inputs -

| Source | kg P/ yr | % of total |
|---|---|---|
| a. Tributaries (non-point load) - | | |
| East Fork Trinity River | 29,130 | 32.8 |
| White Rock Creek | 120 | 0.1 |
| Wilson Creek | 10,830 | 12.2 |
| Sister Grove Creek | 5,175 | 5.8 |
| Pilot Grove Creek | 10,830 | 12.2 |
| Indian Creek | 1,730 | 2.0 |
| b. Minor tributaries & immediate drainage (non-point load) - | 2,765 | 3.1 |
| c. Known municipal STP's - | | |
| Anna | 370 | 0.4 |
| Blue Ridge | 455 | 0.5 |
| Farmersville | 1,405 | 1.6 |
| Leonard | 1,135 | 1.3 |
| McKinney | | |
| North | 1,310 | 1.5 |
| South | 16,655 | 18.8 |
| Posey Mobile Home Acres | 30 | <0.1 |
| Princeton | 3,790 | 4.3 |
| Sets Lagos | 145 | 0.2 |
| Tom Bean | 455 | 0.5 |
| Trenton | 735 | 0.8 |
| Van Alstyne | 775 | 0.9 |
| d. Septic tanks* - | 80 | 0.1 |
| e. Known industrial - None | - | - |
| f. Direct precipitation** - | 785 | 0.9 |
| Total | 88,705 | 100.0 |

2. Outputs -

| | |
|---|---|
| Lake outlet - East Fork Trinity River | 20,000 |

3. Net annual P accumulation - 68,705 kg.

* Estimate based on 261 lakeshore dwellings, seven parks, and one camp, see Working Paper No. 175.
** See Working Paper No. 175.

C. Annual Total Nitrogen Loading - Average Year:

1. Inputs -

| Source | kg N/yr | % of total |
|---|---|---|
| a. Tributaries (non-point load) - | | |
| East Fork Trinity River | 274,705 | 31.5 |
| White Rock Creek | 10,420 | 1.2 |
| Wilson Creek | 133,805 | 15.3 |
| Sister Grove Creek | 88,190 | 10.1 |
| Pilot Grove Creek | 138,075 | 15.8 |
| Indian Creek | 44,160 | 5.1 |
| b. Minor tributaries & immediate drainage (non-point load) - | 70,625 | 8.1 |
| c. Known municipal STP's - | | |
| Anna | 1,105 | 0.1 |
| Blue Ridge | 1,360 | 0.1 |
| Farmersville | 1,660 | 0.2 |
| Leonard | 3,400 | 0.4 |
| McKinney | | |
| North | 1,695 | 0.2 |
| South | 37,990 | 4.4 |
| Posey Mobile Home Acres | 95 | <0.1 |
| Princeton | 6,195 | 0.7 |
| Sets Lagos | 360 | <0.1 |
| Tom Bean | 1,360 | 0.2 |
| Trenton | 2,210 | 0.3 |
| Van Alstyne | 2,220 | 0.3 |
| d. Septic tanks* - | 3,100 | 0.4 |
| e. Known industrial - None | - | - |
| f. Direct precipitation** - | 48,410 | 5.6 |
| Total | 871,115 | 100.0 |

2. Outputs -

| | |
|---|---|
| Lake outlet - East Fork Trinity River | 395,285 |

3. Net annual N accumulation - 475,830 kg.

* Estimate based on 261 lakeshore dwellings, seven parks, and one camp; see Working Paper No. 175.
** See Working Paper No. 175.

D. Non-point Nutrient Export by Subdrainage Area:

| Tributary | kg P/km²/yr | kg N/km²/yr |
|---|---|---|
| East Fork Trinity River | 54 | 513 |
| White Rock Creek | 7 | 576 |
| Wilson Creek | 37 | 453 |
| Sister Grove Creek | 16 | 301 |
| Pilot Grove Creek | 21 | [illegible] |

E. Mean Nutrient Concentrations in Ungaged Streams:

| Tributary | Mean Total P Conc. (mg/l) | Mean Total N Conc. (mg/l) |
|---|---|---|
| Elm Creek | 0.284 | 2.008 |
| Arnold Creek | 0.109 | 0.876 |

F. Yearly Loads:

In the following table, the existing phosphorus loadings are compared to those proposed by Vollenweider (Vollenweider and Dillon, 1974). Essentially, his "dangerous" loading is one at which the receiving water would become eutrophic or remain eutrophic; his "permissible" loading is that which would result in the receiving water remaining oligotrophic or becoming oligotrophic if morphometry permitted. A mesotrophic loading would be considered one between "dangerous" and "permissible".

Note that Vollenweider's model may not be applicable to water bodies with short hydraulic retention times.

| | Total Phosphorus | | Total Nitrogen | |
|---|---|---|---|---|
| | Total | Accumulated | Total | Accumulated |
| grams/$m^2$/yr | 1.03 | 0.79 | 10.1 | 5.5 |

Vollenweider phosphorus loadings ($g/m^2/yr$) based on mean depth and mean hydraulic retention time of Lake Lavon:

| | |
|---|---|
| "Dangerous" (eutrophic loading) | 0.42 |
| "Permissible" (oligotrophic loading) | 0.21 |

V. LITERATURE REVIEWED

Anonymous, 1971. Inventory of municipal waste facilities. EPA Pub. No. OWP-1, vol. 6., Wash., DC.

Anonymous, 1974(?). Intensive surface water monitoring survey for segment 0821 (Lake Lavon). Rept. No. IMS 6, TX Water Qual. Bd., Austin.

Barrows, David, 1977. Personal communication (reservoir morphometry and hydraulic retention time). Cayon Proj. Off.; Fort Worth Distr., Corps of Engrs., New Braunfels, TX.

Vollenweider, R. A., and P. J. Dillon, 1974. The application of the phosphorus loading concept to eutrophication research. Natl. Res. Council of Canada Publ. No. 13690, Canada Centre for Inland Waters, Burlington, Ontario.

## VI. APPENDICES

# APPENDIX A

## LAKE RANKINGS

LAKES RANKED BY INDEX NO.

| RANK | LAKE CODE | LAKE NAME | INDEX NO. |
|---|---|---|---|
| 29 | [illegible] | LYNDON B. JOHNSON LAKE | 239 |
| 30 | [illegible] | TEXOMA LAKE | 237 |
| 31 | [illegible] | SOMERVILLE LAKE | 234 |
| 32 | [illegible] | SAN ANGELO RESERVOIR | 230 |
| 33 | [illegible] | TEXARKANA LAKE | 179 |
| 34 | [illegible] | GARZA LITTLE ELM RESERVO | 173 |
| 35 | [illegible] | TRAVIS LAKE | 154 |
| 36 | [illegible] | BRAUNIG LAKE | 154 |
| 37 | [illegible] | CORPUS CHRISTI LAKE | 155 |
| 38 | [illegible] | HOUSTON LAKE | 136 |
| 39 | [illegible] | LEWISVILLE LAKE | 90 |

| | | |

PERCENT OF LAKES WITH HIGHER VALUES  NUMBER OF LAKES WITH HIGHER VALUES

| LAKE CODE | LAKE NAME | [illegible] TOTAL P | [illegible] INORG N | [illegible] CHLA SEC | [illegible] CHLA CHLA | [illegible] PERC SD | [illegible] COLOR [illegible] P | [illegible] NO |
|---|---|---|---|---|---|---|---|---|
| 426 | SUMERVILLE LAKE | 25 ( 113) | 55 ( 233) | 24 ( 99) | 3 ( 17) | 67 ( 254) | 30 ( 108) | 404 |
| 428 | STAMPING LAKE | 18 ( 71) | 47 ( 177) | 5 ( 23) | 18 ( 71) | 62 ( 334) | 39 ( 144) | 259 |
| 430 | STILLWATER YELLOW PERCH | 69 ( 333) | 37 ( 147) | 67 ( 333) | 42 ( 354) | 17 ( 61) | 51 ( 198) | 312 |
| 432 | TAMARAC LAKE | 32 ( 127) | 78 ( 280) | 27 ( 104) | 21 ( 69) | 63 ( 244) | 38 ( 161) | 253 |
| 433 | TOMAHAWK LAKE | 11 ( 44) | 51 ( 198) | 13 ( 51) | 36 ( 84) | 72 ( 277) | 13 ( 59) | 176 |
| 434 | TOMAH LAKE | 39 ( 244) | 34 ( 139) | 61 ( 233) | 45 ( 177) | 17 ( 81) | 21 ( 71) | 217 |
| 435 | TWISS LAKE | 68 ( 339) | 23 ( 71) | 42 ( 354) | 82 ( 334) | 17 ( 61) | 84 ( 334) | 564 |
| 436 | WINDING | 8 ( 19) | 61 ( 227) | 11 ( 44) | 5 ( 23) | 42 ( 152) | 8 ( 19) | 169 |
| 437 | WOLF RIVER RESERVOIR | 55 ( 227) | 23 ( 71) | 58 ( 227) | 61 ( 273) | 44 ( 179) | 63 ( 231) | 311 |
| 438 | WHITE HORSE RESERVOIR | 84 ( 327) | 61 ( 227) | 76 ( 299) | 69 ( 342) | 17 ( 81) | 63 ( 231) | 348 |
| 439 | WHITNEY LAKE | 65 ( 264) | 51 ( 199) | 76 ( 301) | 71 ( 275) | 17 ( 61) | 76 ( 280) | 357 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |

# APPENDIX B

## CONVERSION FACTORS

## CONVERSION FACTORS

Hectares x 2.471 = acres

Kilometers x 0.6214 = miles

Meters x 3.281 = feet

Cubic meters x 8.107 x $10^{-4}$ = acre/feet

Square kilometers x 0.3861 = square miles

Cubic meters/sec x 35.315 = cubic feet/sec

Centimeters x 0.3937 = inches

Kilograms x 2.205 = pounds

Kilograms/square kilometer x 5.711 = lbs/square mile

# APPENDIX C

## TRIBUTARY FLOW DATA

# APPENDIX D

# PHYSICAL and CHEMICAL DATA

# APPENDIX E

## TRIBUTARY AND WASTEWATER TREATMENT PLANT DATA

[illegible]

| DATE | TIME | DEPTH | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
|---|---|---|---|---|---|---|---|
| [illegible] | | | | | | | |
| [illegible] | | | | | | | |

[illegible]

[illegible]

[illegible]
[illegible]
[illegible]
[illegible]
[illegible]
[illegible]
[illegible]

| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
|---|---|---|---|---|---|---|---|
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |

[illegible]

[illegible]

[illegible]

| DATE | TIME | LEVEL | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
|---|---|---|---|---|---|---|---|
| FLOW | TO | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| TO | DAY | FEET | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | 11 | 15 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | 11 | 02 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | 12 | 46 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | 11 | 10 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | 11 | 75 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | 11 | 37 | [illegible] | [illegible] | [illegible] | [illegible] | |
| [illegible] | 11 | 01 | [illegible] | [illegible] | [illegible] | [illegible] | |
| [illegible] | 11 | 15 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | 11 | 45 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | 11 | 15 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | 11 | 15 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | 09 | 58 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | 09 | 58 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | 24 | 42 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |

[illegible]

[illegible]

[illegible]

[illegible]

| DATE | TIME | DEPTH | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
|---|---|---|---|---|---|---|---|
| FROM | OF | | [illegible] | % | TOTAL | [illegible] | |
| TO | DAY | FEET | MG/L | MG/L | MG/L | MG/L * | MG/L * |
| [illegible] | 18 | 0 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | 18 | 50 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | 12 | 20 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | 18 | 50 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | 11 | 10 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | 11 | 20 | [illegible] | [illegible] | [illegible] | [illegible] | |
| [illegible] | 10 | 40 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | 24 | 00 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | 11 | 50 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | 11 | 25 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | 11 | 35 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | 09 | 40 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | 09 | 40 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | 14 | 30 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |

< VALUE KNOWN TO BE
LESS THAN INDICATED

[illegible]

[illegible]

[illegible]

| [illegible] | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| [illegible] | | | | | | | | | | |
| [illegible] | | | | | | | | | | |
| [illegible] | | | | | | | | | | |
| [illegible] | | | | | | | | | | |
| [illegible] | | | | | | | | | | |
| [illegible] | | | | | | | | | | |
| [illegible] | | | | | | | | | | |
| [illegible] | | | | | | | | | | |
| [illegible] | | | | | | | | | | |
| [illegible] | | | | | | | | | | |
| [illegible] | | | | | | | | | | |

* [illegible]
[illegible]

[illegible]

[illegible]

| DATE | TIME | DEPTH | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
|---|---|---|---|---|---|---|---|---|---|
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| TO | DAY | FEET | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 75/02/25 | 14 | 15 | 1.286 | 1.0029 | 0.123 | 0.041 | 0.1004 | 0.805 | |
| 75/03/23 | 11 | 00 | 8.65 | 1.285 | 0.009 | 0.111 | 0.133 | 0.207 | 0.007 |
| 75/02/21 | 10 | 00 | 23.200 | 1.0004 | 0.131 | 0.465 | 0.488 | 0.245 | 0.146 |
| 75/03/25 | 11 | 00 | 2.205 | 1.286 | 0.0004 | 0.148 | 0.158 | 0.004 | 0.007 |
| 75/04/01 | 15 | 10 | 2.300 | 0.5004 | 0.007 | 0.105 | 0.578 | 0.027 | 0.004 |
| 75/04/24 | 15 | 10 | 1.401 | 2.401 | 0.007 | 0.401 | 1.001 | 0.004 | 0.007 |
| 75/05/22 | 14 | 10 | 2.256 | 1.405 | 0.004 | 0.415 | 0.538 | 0.007 | 0.004 |
| 75/06/04 | 11 | 10 | 2.200 | 0.410 | 0.0004 | 0.425 | 0.700 | 0.009 | 0.010 |
| 75/06/24 | 11 | 00 | 0.205 | 2.200 | 0.001 | 0.401 | 0.500 | 0.005 | 0.004 |
| 75/06/25 | 10 | 10 | 0.400 | 0.500 | 0.025 | 0.400 | 0.040 | 0.005 | 0.000 |

* VALUE KNOWN TO BE LESS THAN INDICATED

[illegible]